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Lin et al.

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(54) **FAN MODULE**

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F04D 29/18 (2006.01)

(52) **U.S. Cl.**
CPC ***F04D 29/181*** (2013.01); ***F04D 25/08*** (2013.01)

(58) **Field of Classification Search**
CPC F04D 29/181; F04D 25/08
USPC 416/179
See application file for complete search history.

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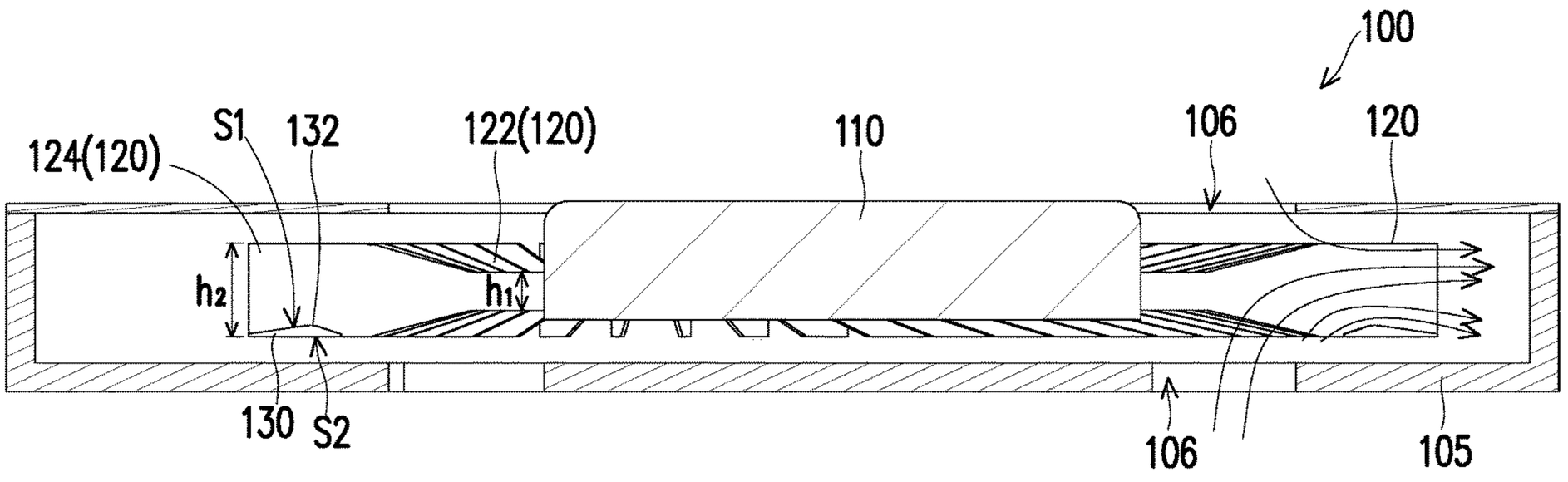
(57) **ABSTRACT**

A fan module includes a hub, a plurality of fan blades, and a ring frame. The hub is configured to rotate about a central axis. The plurality of fan blades surround the hub. Each of the plurality of fan blades includes a first end portion connected to the hub and a second end portion opposite to the first end portion. The ring frame is connected to the second end portion of each of the plurality of fan blades. The ring frame includes a first surface facing the plurality of fan blades and a second surface opposite to the first surface, and the first surface is a curved surface.

11 Claims, 12 Drawing Sheets



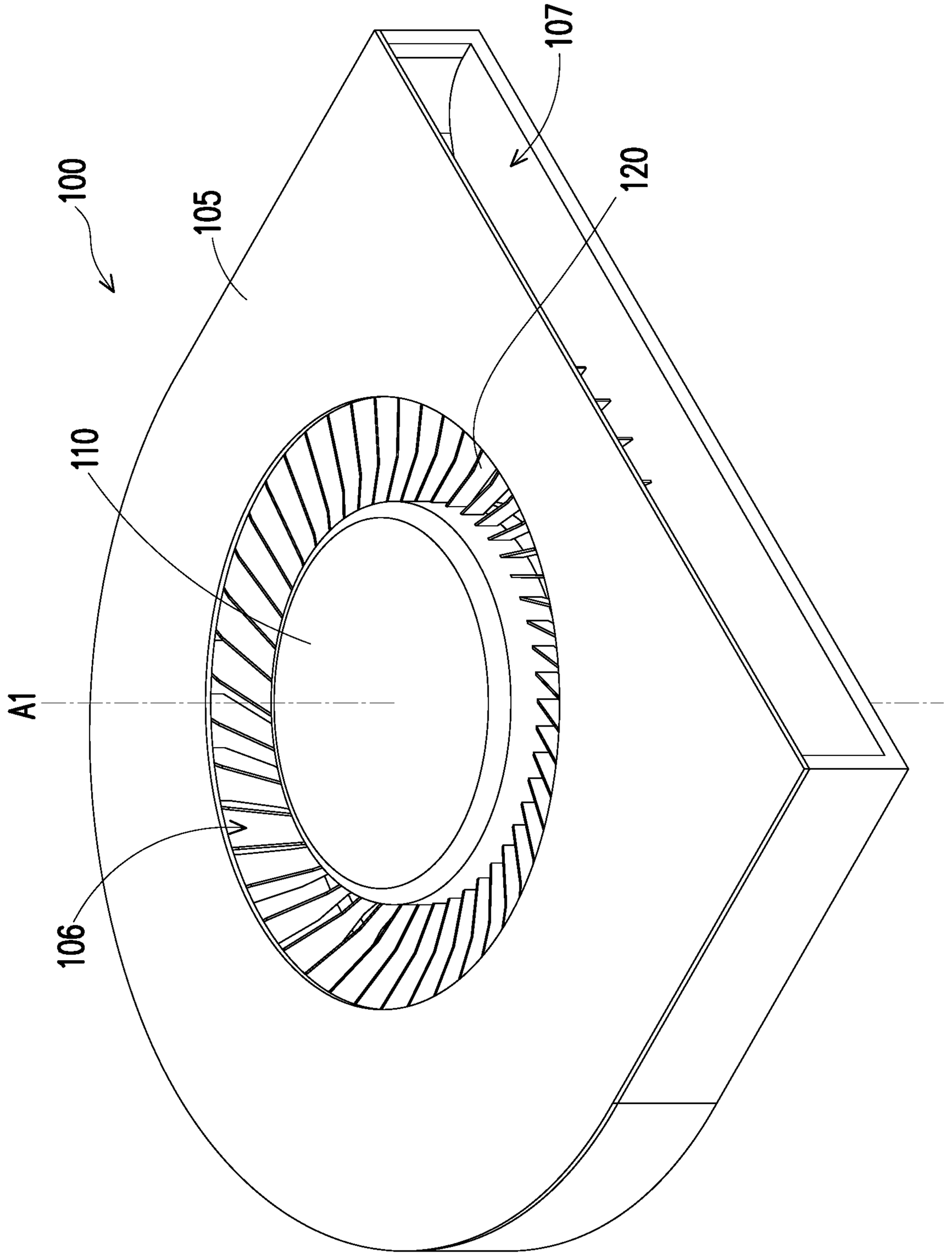


FIG. 1

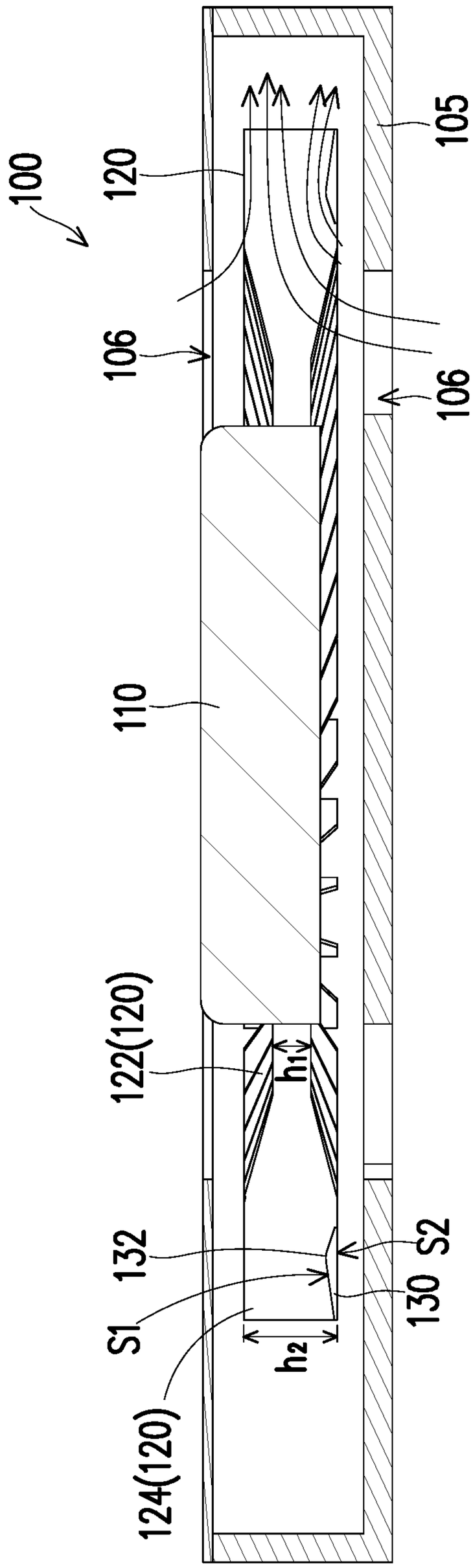


FIG. 2

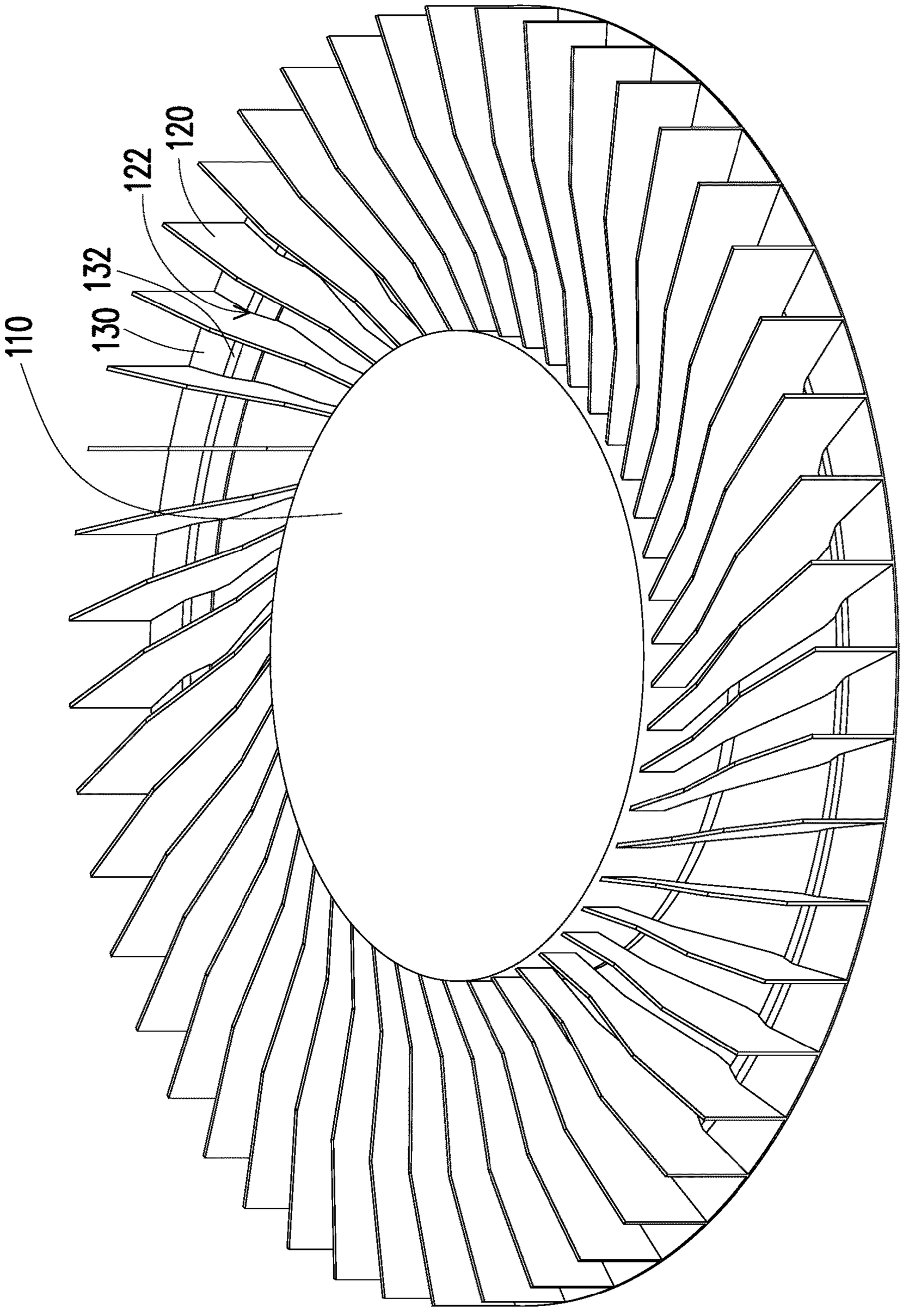


FIG. 3

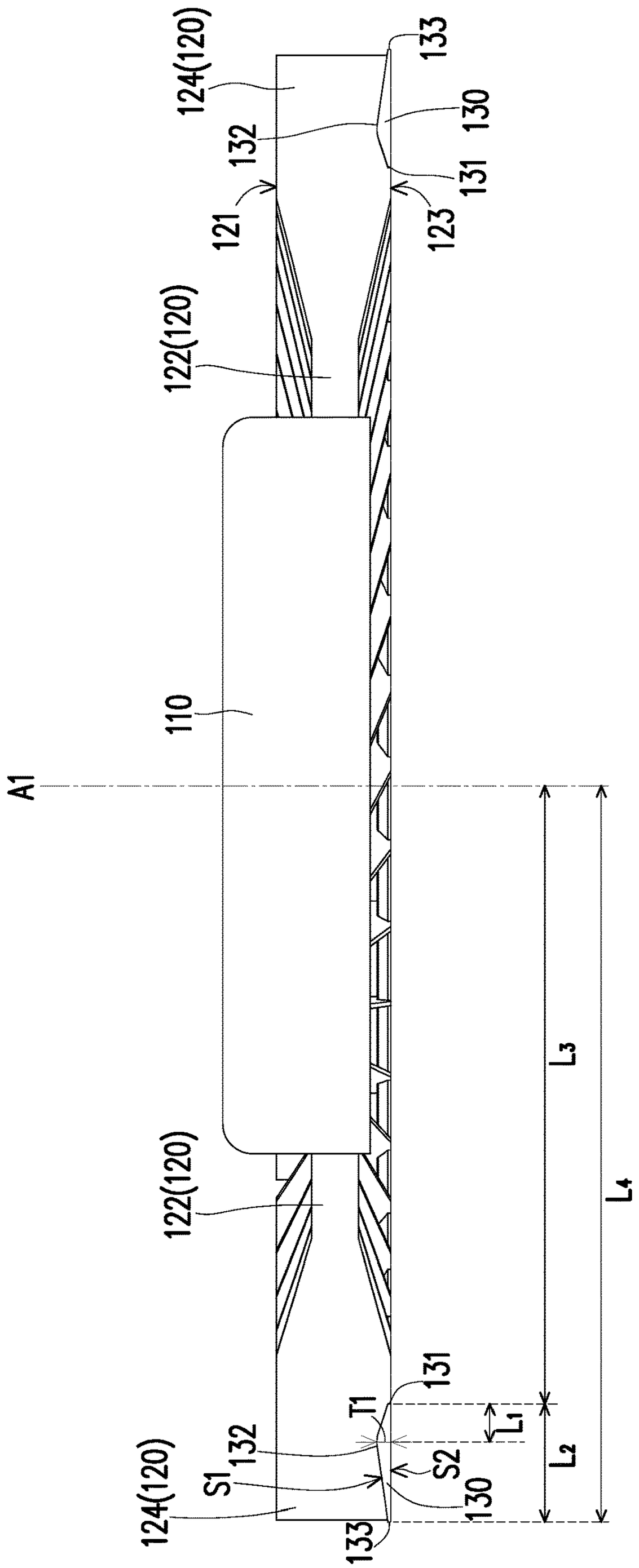

124(120)
133
130
132
131
121
123
122(120)
110
A1
L3
L4
122(120)
131
T1
L1
132
L2
S2
S1
130
124(120)
133

FIG. 4

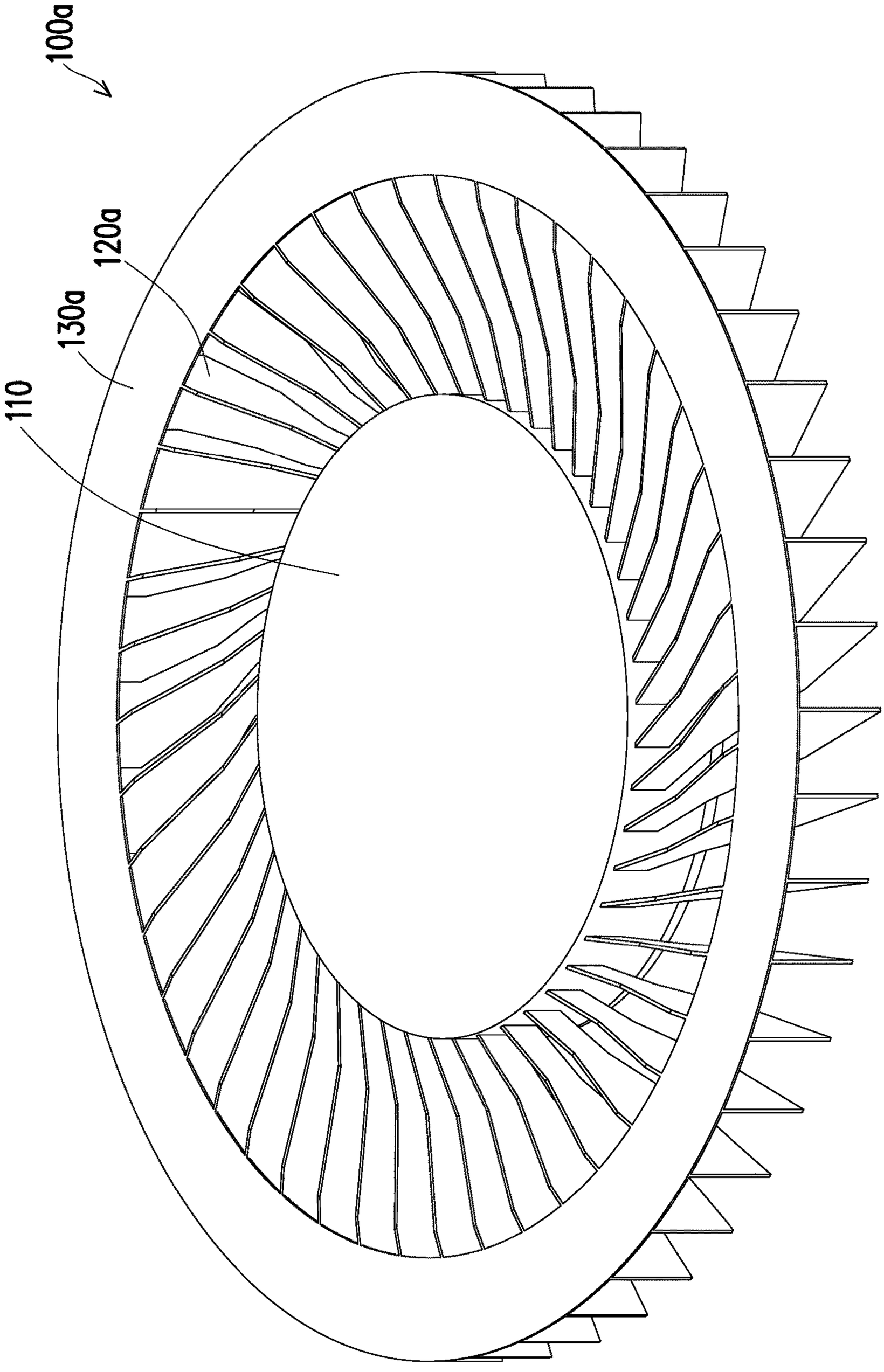


FIG. 5

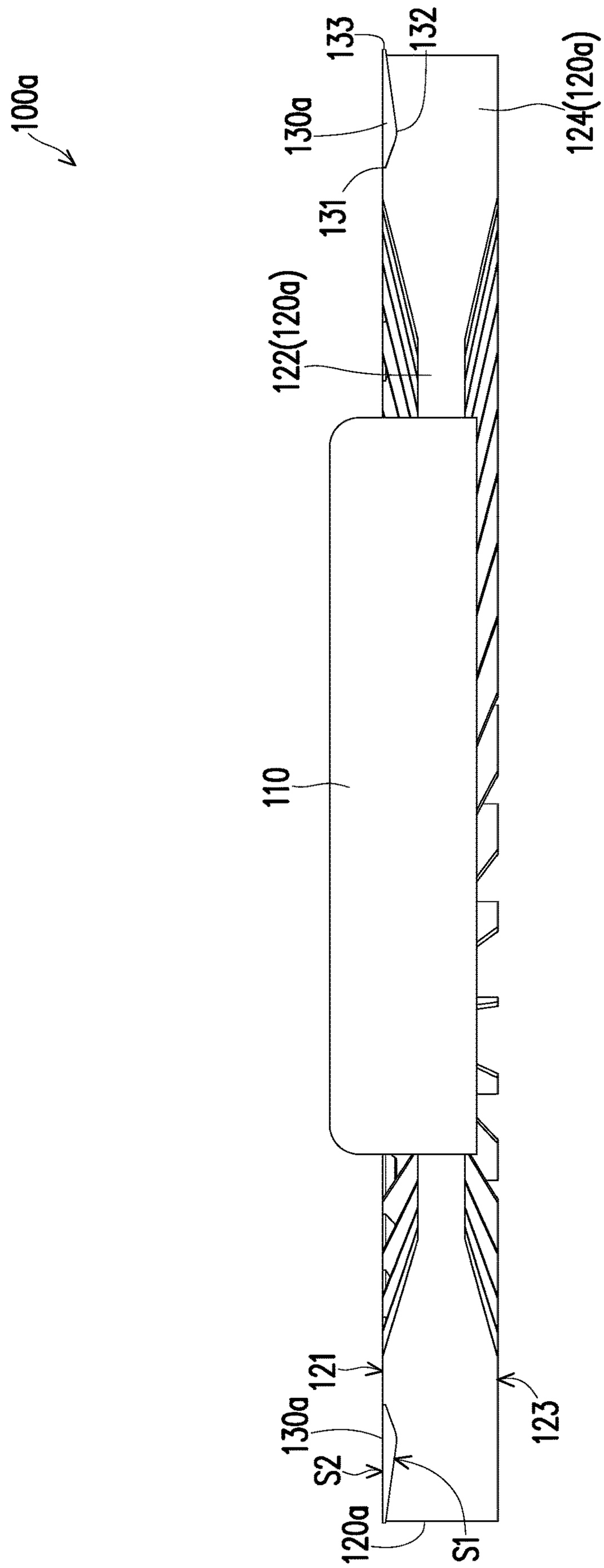

100a
133
132
130a
124(120a)
131
122(120a)
110
121
130a
S2
120a
S1
123

FIG. 6

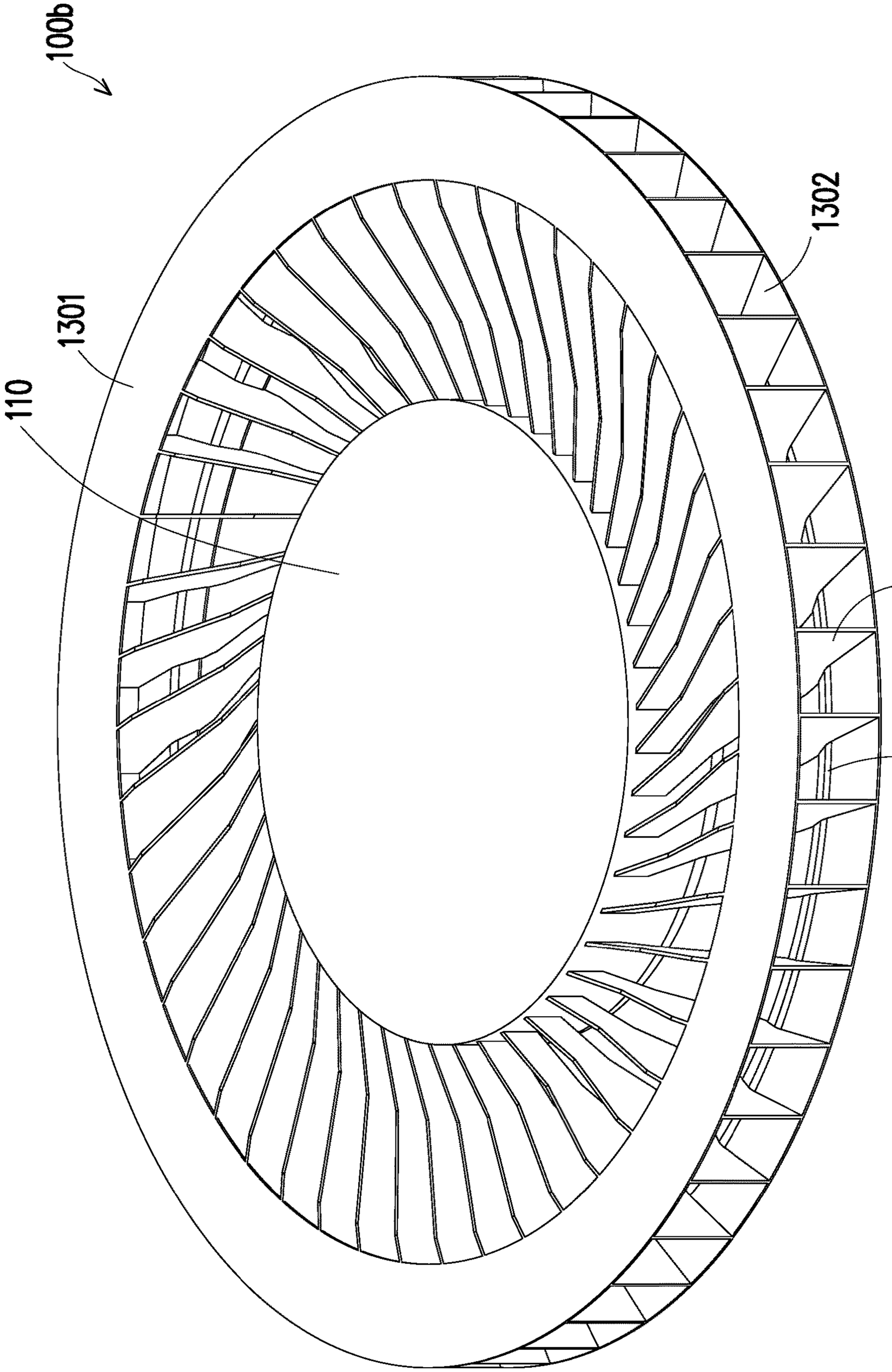


FIG. 7

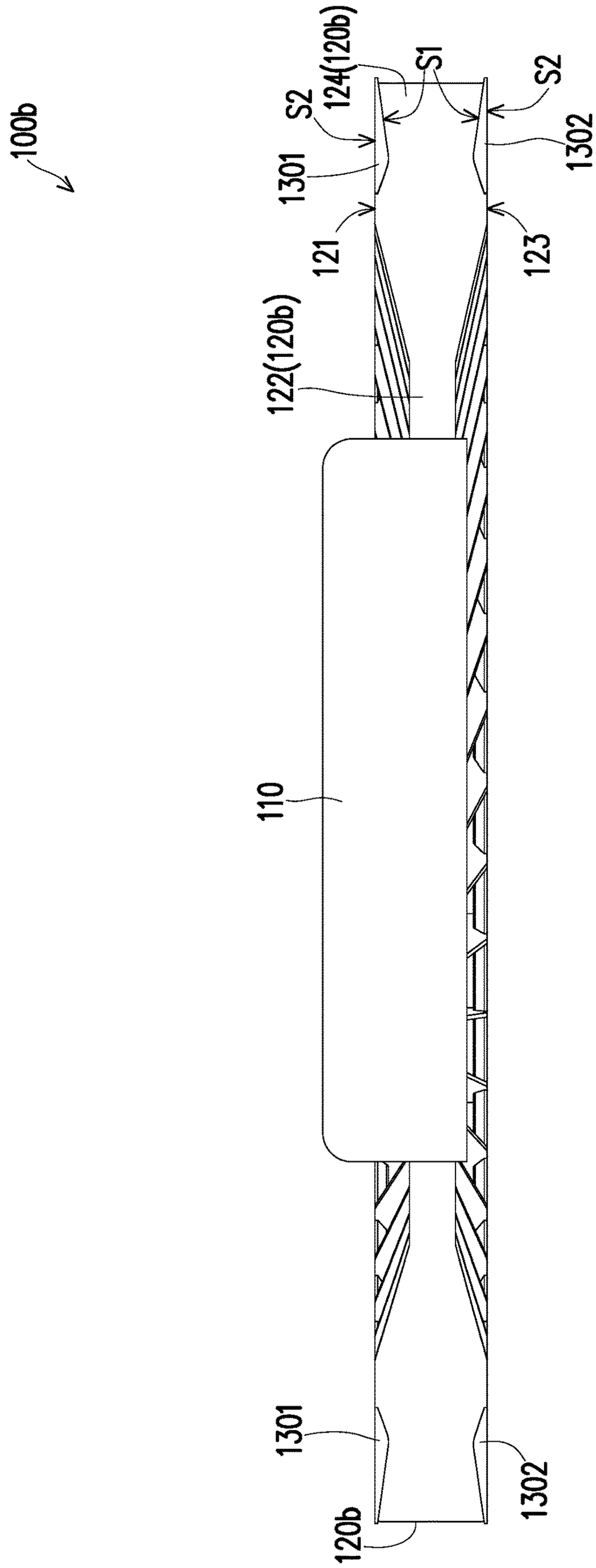

100b
124(120b)
S1
S2
S2
1301
1302
121
123
122(120b)
110
1301
1302
120b

FIG. 8

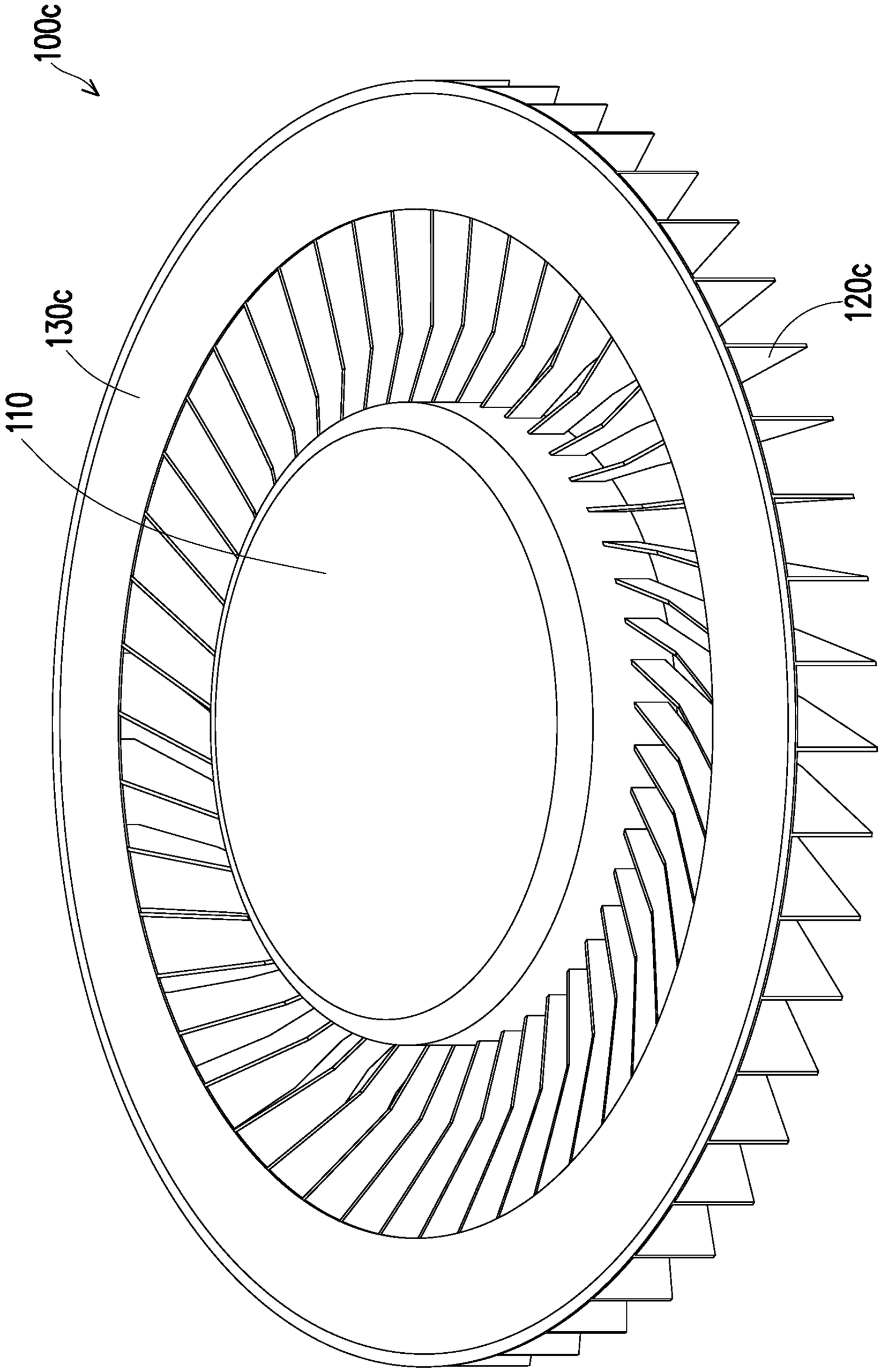


FIG. 9

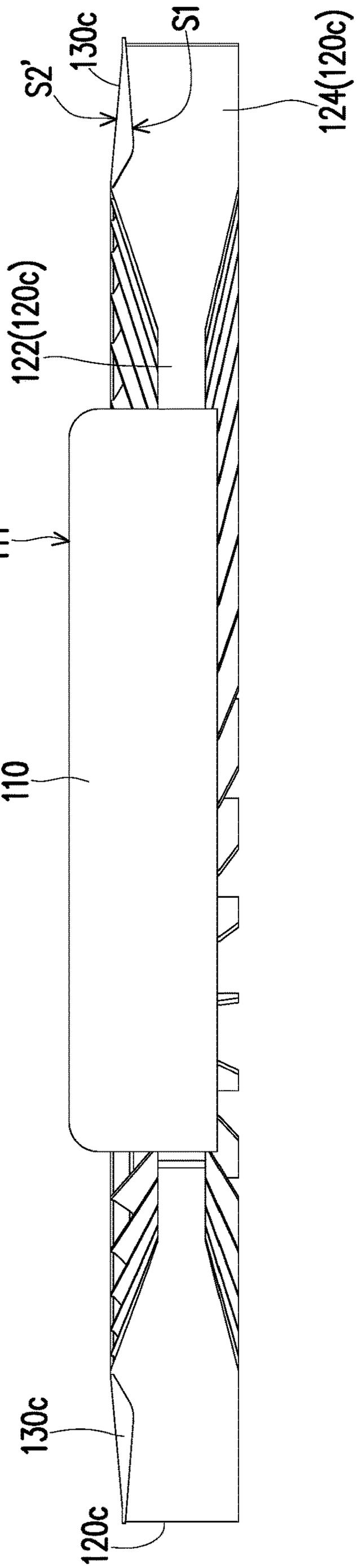


FIG. 10

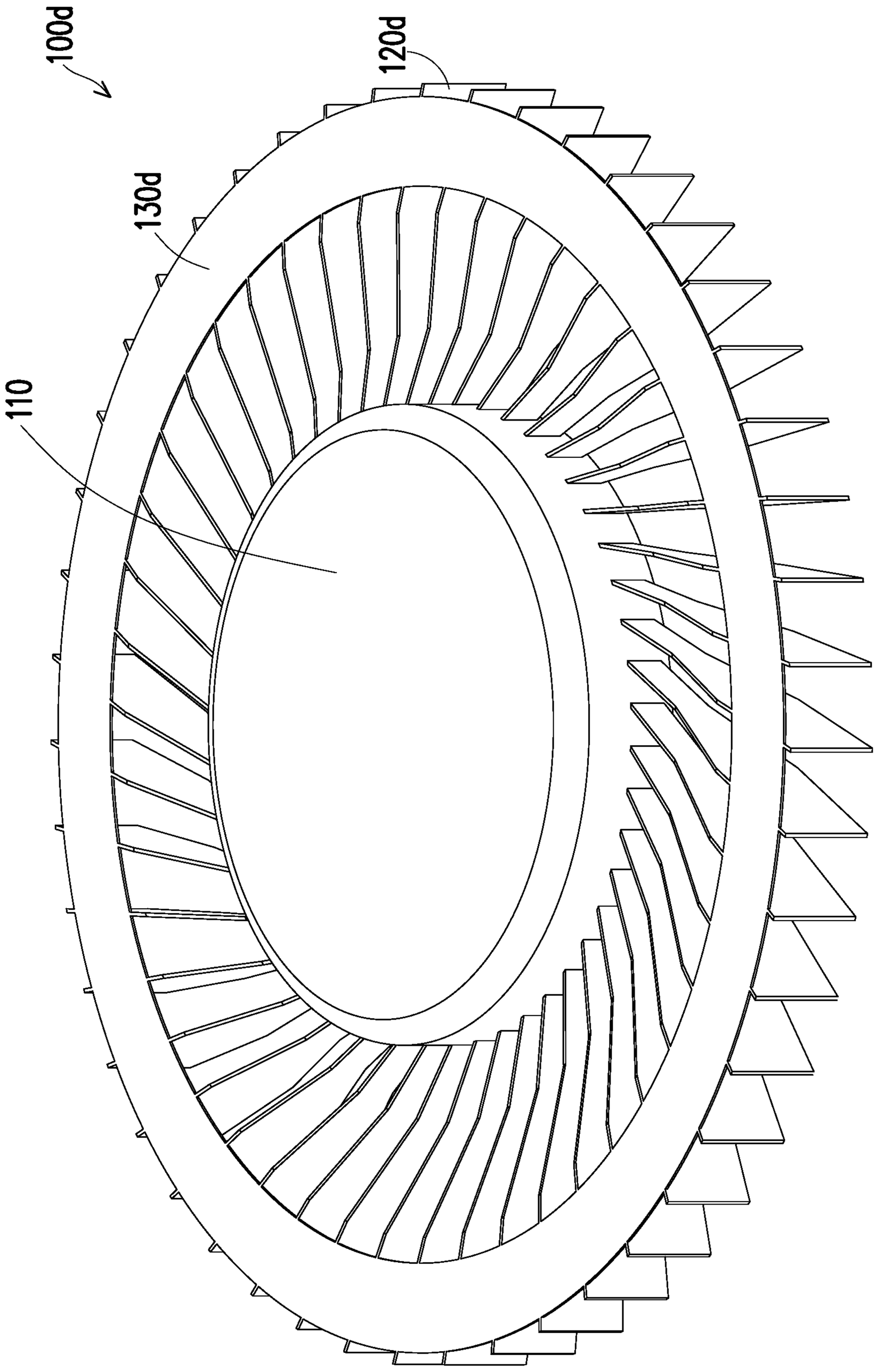


FIG. 11

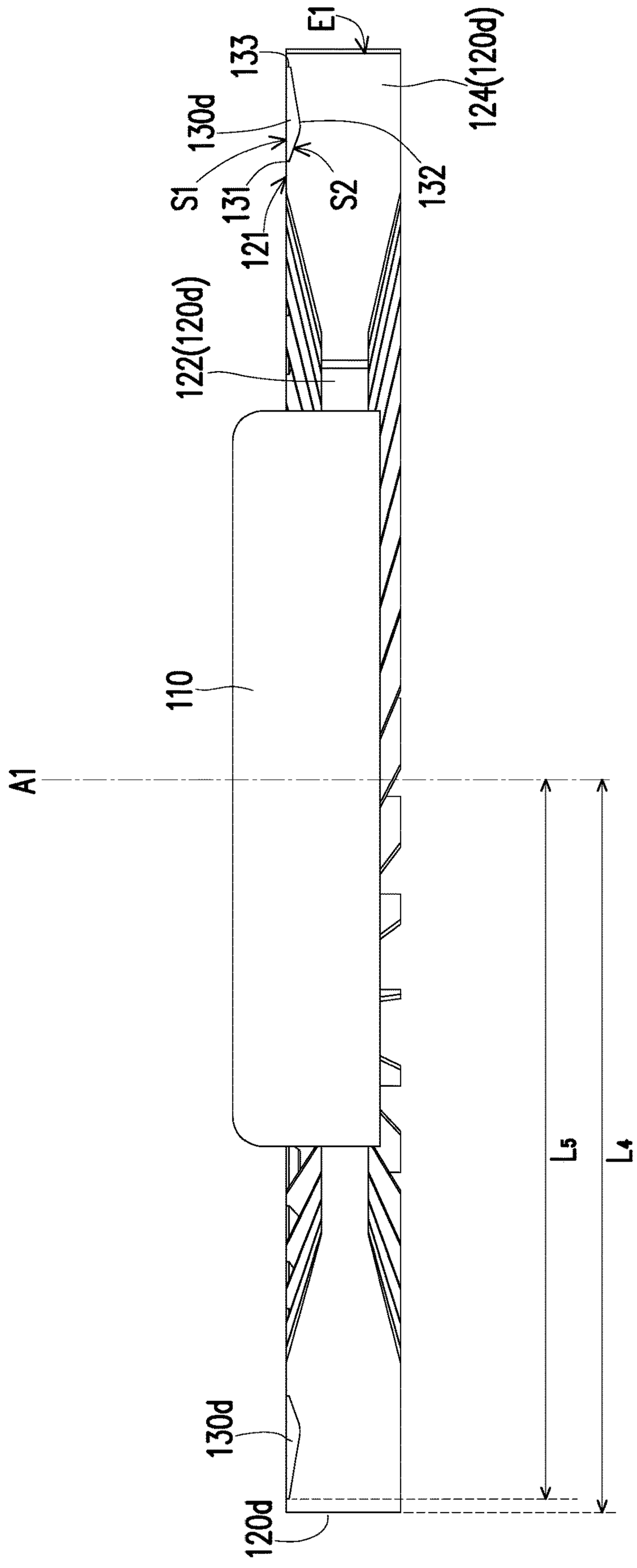

E1
133
124(120d)
130d
S1
131
121
S2
132
122(120d)
110
A1
L5
L4
130d
120d

FIG. 12

FAN MODULE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the priority benefit of Taiwan application serial no. 111136338, filed on Sep. 26, 2022. The entirety of the above-mentioned patent application is hereby incorporated by reference herein and made a part of this specification.

BACKGROUND

Technical Field

The disclosure relates to a fan module.

Description of Related Art

Generally speaking, a rotor of a fan includes a plurality of blades connected to a central hub. As electronic products have evolved to become lighter and thinner, the volumes of fans installed in electronic products to be used for heat dissipation for electronic components also become smaller. As a result, the spacing between the blades becomes smaller, and the thickness decreases as well. However, as a consequence of the decreased thickness of the blades, there comes the problem of structural strength insufficiency. If a frame is installed to strengthen the blades, then the airflow is affected, and thus the performance of the fan is affected.

SUMMARY

According to an aspect of this disclosure, a fan module is provided. The fan module includes a hub, a plurality of fan blades, and a ring frame. The hub is configured to rotate about a central axis. The plurality of fan blades surround the hub. Each of the plurality of fan blades includes a first end portion connected to the hub and a second end portion opposite to the first end portion. The ring frame is connected to the second end portion of each of the plurality of fan blades, and the ring frame includes a first surface facing the plurality of fan blades and a second surface opposite to the first surface, and the first surface is a curved surface.

Based on the above, the ring frame of the fan module of the disclosure is connected to the outer endpoint of each of the fan blades, thereby strengthening the structural strength of the fan blades and reducing the situation that the fan blades are easily deformed or even broken due to the thinness of the fan blades. Moreover, the ring frame is designed in such a way that the camber of the inner surface facing the fan blades is larger, and the camber of the outer surface is gentler. This configuration can form a pressure difference between the inner surface facing the fan blades and the opposing outer surface of the ring frame, thereby promoting the airflow and improving the performance of the fan module. Therefore, the fan module of the disclosure can improve or at least maintain the performance of the fan module while strengthening the structural strength of the fan blades.

To make the aforementioned more comprehensible, several embodiments accompanied with drawings are described in detail as follows.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the disclosure, and are incorporated

in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the disclosure and, together with the description, serve to explain the principles of the disclosure.

FIG. **1** is a schematic perspective view of a fan module according to an embodiment of the disclosure.

FIG. **2** is a schematic cross-sectional view of a fan module according to an embodiment of the disclosure.

FIG. **3** is a schematic perspective view of some components of a fan module according to an embodiment of the disclosure.

FIG. **4** is a schematic cross-sectional view of some components of a fan module according to an embodiment of the disclosure.

FIG. **5** is a schematic perspective view of a fan module according to an embodiment of the disclosure.

FIG. **6** is a schematic cross-sectional view of a fan module according to an embodiment of the disclosure.

FIG. **7** is a schematic perspective view of a fan module according to an embodiment of the disclosure.

FIG. **8** is a schematic cross-sectional view of a fan module according to an embodiment of the disclosure.

FIG. **9** is a schematic perspective view of a fan module according to an embodiment of the disclosure.

FIG. **10** is a schematic cross-sectional view of a fan module according to an embodiment of the disclosure.

FIG. **11** is a schematic perspective view of a fan module according to an embodiment of the disclosure.

FIG. **12** is a schematic cross-sectional view of a fan module according to an embodiment of the disclosure.

DESCRIPTION OF THE EMBODIMENTS

Regarding the aforementioned and other technical contents, features and advantages of the disclosure, they are to be described more comprehensively with each embodiment accompanied with reference figures hereinafter. In the following embodiments, wordings used to indicate directions, such as "up," "down," "front," "back," "left", and "right", merely refer to directions in the accompanying drawings. Therefore, the wordings used to indicate directions are used to illustrate rather than to limit the disclosure. Also, in each of the following embodiments, the same or similar reference numerals or labels represent the same or similar components.

FIG. **1** is a schematic perspective view of a fan module according to an embodiment of the disclosure. FIG. **2** is a schematic cross-sectional view of a fan module according to an embodiment of the disclosure. Please refer to FIG. **1** and FIG. **2** simultaneously. In some embodiments, the fan module **100** includes a casing **105**, a hub **110**, a plurality of fan blades **120**, and a ring frame **130**. The hub **110** is disposed in the casing **105** and exposed to the outside through an opening of the casing **105**. The hub **110** is configured to rotate about a central axis A**1** of the fan module **100**. The plurality of fan blades **120** are respectively disposed around the hub **110** to rotate about the central axis A**1** when driven by the hub **110**. In some embodiments, the casing **105** may include an air inlet **106** and an air outlet **107**. In this embodiment, the air inlets **106** can be located on the upper and lower sides of the casing **105**, and the air outlet **107** can be located on a side of the casing **105**. In this way, the fan module **100** can use the air inlets **106** on the upper and lower sides to draw in the airflow from the outside, and use the air outlet **107** located on the side to send out air sideways. Of course, this embodiment is only an example, and the dis-

closure is not intended to limit the configuration of the air inlet and the air outlet of the fan module.

In some embodiments, each of the fan blades **120** may include a first end portion **122** and a second end portion **124** opposite to each other. The first end portions **122** are respectively connected to an outer side surface of the hub **110**, and the second end portions **124** are opposite to the first end portions **122**. In this embodiment, a thickness h1 of the first end portion **122** may be smaller than a thickness h2 of the second end portion **124**. Specifically speaking, the thickness h1 of the part connecting the hub **110** in the first end portion **122** is approximately smaller than the thickness h2 of the second end portion **124**, but the disclosure is not limited thereto.

FIG. **3** is a schematic perspective view of some components of a fan module according to an embodiment of the disclosure. FIG. **4** is a schematic cross-sectional view of some components of a fan module according to an embodiment of the disclosure. It should be noted that, in order to show the internal structure of the fan module more clearly, the illustration of the casing **105** of the fan module is omitted from FIG. **3** to FIG. **12**. Please refer to FIG. **2** to FIG. **4** simultaneously. In some embodiments, the ring frame **130** surrounds the outer edge of each of the plurality of fan blades **120**, and is connected to the second end portion **124** of each of the fan blades **120**, wherein the ring frame **130** includes a first surface S**1** facing the fan blades **120** and a second surface S**2** opposite to the first surface S**1**, and the first surface S**1** is a curved surface as shown in FIG. **4**. In this embodiment, the first surface S**1** is a curved surface protruding towards the second end portion **124**, and the second surface S**2** is a plane surface (with zero camber). In other embodiments, the second surface S**2** can also be a curved surface or an inclined surface, as long as the surface area of the first surface S**1** is approximately larger than the surface area of the second surface S**2**, or the camber of the first surface S**1** is approximately larger than the camber of the second surface S**2**.

In such a configuration, the ring frame **130** is connected to the second end portion **124** of each of the fan blades **120**, thereby strengthening the structural strength of the fan blades **120** and reducing the situation that the fan blades **120** are easily deformed or even broken due to the thinness of the fan blades. In addition, the ring frame **130** is designed in such a way that the first surface S**1** has a larger camber and the second surface S**2** has a gentler camber. Therefore, when the airflow flows through the second surface S**2** with a smaller camber, the speed does not increase too much. Accordingly, the airflow pressure is not reduced too much. In contrast, when the airflow flows through the first surface S**1** with a larger camber, the speed increases a lot, so the airflow pressure decreases a lot. This configuration can form a pressure difference between the first surface S**1** (facing the inner surface of the fan blades **120**) and the second surface S**2** (facing the outer surface) of the ring frame **130**, thereby promoting the airflow and improving the performance of the fan module **100**. Therefore, the fan module **100** can improve or at least maintain the performance of the fan module **100** while strengthening the structural strength of the fan blades **120**.

Please refer to FIG. **4**. Specifically speaking, in some embodiments, the ring frame **130** may include an inner edge **131** and an outer edge **133** opposite to each other, wherein the inner edge **131** is close to the first end portion **122** of each of the fan blades **120**, and the outer edge **133** is close to the second end portion **124** of each of the fan blades **120**. In this embodiment, the thickness of the inner edge **131** and the thickness of the outer edge **133** are both smaller than the maximum thickness T1 of the ring frame **130** at the peak point **132** of the curved surface. In this embodiment, the ring frame **130** is disposed on the lower side of the fan blades **120**. Specifically speaking, the ring frame **130** is connected to the lower surface **123** of each of the fan blades **120**. The lower surface **123** of each of the fan blades **120** may have a notch corresponding to the curved first surface S**1** of the ring frame **130**, so that the ring frame **130** is fitted with the lower surface **123** of each of the fan blades **120**. Moreover, in this embodiment, the second surface S**2** of the ring frame **130** can be coplanar with the lower surface **123** of each of the fan blades **120** to reduce wind resistance.

In one embodiment, the maximum thickness T1 of the ring frame **130** (e.g., the thickness at the peak point **132**) is at least three times the minimum thickness of the ring frame **130** (e.g., the thickness of the inner edge **131** and the thickness of the outer edge **133**). In some embodiments, the shortest distance L1 from the peak point **132** to the inner edge **131** of the ring frame **130** is 28% to 38% of the shortest distance L2 from the inner edge **131** to the outer edge **133**. In one embodiment, the shortest distance L2 from the inner edge **131** to the outer edge **133** is at least five times the maximum thickness T1 of the ring frame **130** (e.g., the thickness at the peak point **132**) (i.e., L2>5T1). In one embodiment, the outer endpoint of each of the fan blades **120** is connected to one another to define a circle, and the inner radius (half of the inner diameter) L3 of the ring frame **130** is substantially larger than 75% of the radius L4 of the circle defined by the outer endpoint of each of the fan blades **120** (i.e., L3>75% of L4). Experiments have confirmed that under the range of sizes mentioned above, the turbulence of the ring frame **130** can be minimized, and even the gas flow can be promoted, so that the performance of the fan module **100** can be optimized. The dimensional configurations described above are applicable to all embodiments of the disclosure.

FIG. **5** is a schematic perspective view of a fan module according to an embodiment of the disclosure. FIG. **6** is a schematic cross-sectional view of a fan module according to an embodiment of the disclosure. It should be noted here that the fan module **100***a* of this embodiment is similar to the fan module **100** of the previous embodiment. Therefore, this embodiment uses the reference numerals and part of the content of the previous embodiment. The same reference numerals are used to denote the same or similar components, and the description of the same technical contents is omitted. For the description of the omitted part, reference may be made to the aforementioned embodiments, which will not be repeated in this embodiment. The following will describe the differences between the fan module **100***a* of this embodiment and the fan module **100** of the previous embodiment.

Please refer to FIG. **5** and FIG. **6** simultaneously. In this embodiment, the ring frame **130** is disposed on the upper side of the fan blades **120**. Specifically speaking, the ring frame **130** is connected to the upper surface **121** of each of the fan blades **120**. In this embodiment, the lower surface **121** of each of the fan blades **120***a* may have a notch corresponding to the curved first surface S**1** of the ring frame **130***a*, so that the ring frame **130***a* is fitted with the upper surface **121** of each of the fan blades **120***a*. Moreover, in this embodiment, the second surface S**2** of the ring frame **130***a* can be coplanar with the upper surface **121** of each of the fan blades **120***a* to reduce wind resistance.

FIG. **7** is a schematic perspective view of a fan module according to an embodiment of the disclosure. FIG. **8** is a schematic cross-sectional view of a fan module according to

an embodiment of the disclosure. It should be noted here that the fan module **100***b* of this embodiment is similar to the fan module **100** of the previous embodiment. Therefore, this embodiment uses the reference numerals and part of the content of the previous embodiment. The same reference numerals are used to denote the same or similar components, and the description of the same technical contents is omitted. For the description of the omitted part, reference may be made to the aforementioned embodiments, which will not be repeated in this embodiment. The following will describe the differences between the fan module **100***b* of this embodiment and the fan module of the previous embodiment.

In this embodiment, the ring frame **130***b* may include a first ring frame **1301** and a second ring frame **1302**. The first ring frame **1301** and the second ring frame **1302** can be disposed on the upper and lower surfaces of each of the fan blades **120***b* respectively. That is to say, the first ring frame **1301** is connected to the upper surface **121** of each of the fan blades **120***b*, and the second ring frame **1302** is connected to the lower surface **123** of each of the fan blades **120***b*. Specifically speaking, the first ring frame **1301** is connected to the upper surface **121** of each of the fan blades **120***b* located in the second end portion **124**, and the second ring frame **1302** is connected to the lower surface **123** of each of the fan blades **120***b* located in the second end portion **124**. In one embodiment, when viewed from the direction of the top view, the positions where the first ring frame **1301** and the second ring frame **1302** are disposed may approximately coincide or at least partially overlap. In this embodiment, the upper surface **121** and the lower surface **123** of each of the fan blades **120***b* may have a notch corresponding to the curved surface (the first surface S**1**) of the first ring frame **1301** and the second ring frame **1302**, so that the first ring frame **1301** is fitted with the upper surface **121** of each of the fan blades **120***b*, and the second ring frame **1302** is fitted with the lower surface **123** of each of the fan blades **120***b*. In addition, in this embodiment, the outer surface (the second surface S**2**) of the first ring frame **1301** may be coplanar with the upper surface **121** of each of the fan blades **120***b*, and the outer surface (the second surface S**2**) of the second ring frame **1302** may be coplanar with the lower surface **123** of each of the fan blades **120***b* to reduce wind resistance.

FIG. **9** is a schematic perspective view of a fan module according to an embodiment of the disclosure. FIG. **10** is a schematic cross-sectional view of a fan module according to an embodiment of the disclosure. It should be noted here that the fan module **100***c* of this embodiment is similar to the fan module of the previous embodiment. Therefore, this embodiment uses the reference numerals and part of the content of the previous embodiment. The same reference numerals are used to denote the same or similar components, and the description of the same technical contents is omitted. For the description of the omitted part, reference may be made to the aforementioned embodiments, which will not be repeated in this embodiment. The following will describe the differences between the fan module **100***c* of this embodiment and the fan module of the previous embodiment.

Please refer to FIG. **9** and FIG. **10** simultaneously. In this embodiment, the second surface S**2'** of the ring frame **130***c* may be an inclined surface. Specifically speaking, the first surface S**1** of the ring frame **130***c* is a curved surface protruding towards each of the fan blades **120***c*, and the second surface S**2'** opposite to the first surface S**1** may be a plane surface. Furthermore, the second surface S**2'** may be inclined with respect to the upper surface **111** of the hub **110**. In this embodiment, the ring frame **130***c* is disposed on the upper surface of each of the fan blades **120***c*. However, in other embodiments, the ring frame **130***c* with an inclined outer surface (the second surface S**2'**) may also be disposed on the lower surface of each of the fan blades **120***c*, or may also be disposed respectively on both the upper and lower surfaces of each of the fan blades **120***c*. The slope of the inclined outer surface (the second surface S**2'**) of the ring frame **130***c* may be adjusted according to the practical needs of the airflow design, and the disclosure is not limited thereto.

FIG. **11** is a schematic perspective view of a fan module according to an embodiment of the disclosure. FIG. **12** is a schematic cross-sectional view of a fan module according to an embodiment of the disclosure. It should be noted here that the fan module **100** of this embodiment is similar to the fan module of the previous embodiment. Therefore, this embodiment uses the reference numerals and part of the content of the previous embodiment. The same reference numerals are used to denote the same or similar components, and the description of the same technical contents is omitted. For the description of the omitted part, reference may be made to the aforementioned embodiments, which will not be repeated in this embodiment. The following will describe the differences between the fan module **100***c* of this embodiment and the fan module of the previous embodiment.

Please refer to FIG. **11** and FIG. **12** simultaneously. In this embodiment, the outer edge **133** of the ring frame may not be aligned with the outer endpoint E**1** of each of the fan blades **120***d*. In other words, when viewed from the direction of the top view, the outer edge **133** of the ring frame **130***d* may not coincide with the outer endpoint E**1** of each of the fan blades **120***d*. Specifically speaking, the outer endpoint E**1** of each of the fan blades **120***d* is connected to one another to define a circle, and the outer radius (half of the outer diameter) L5 of the ring frame **130***d* is approximately smaller than the radius L4 of the circle defined by the outer endpoint E**1** of each of the fan blades **120***d*. In this embodiment, the upper surface **121** of each of the fan blades **120***d* may have a notch corresponding to the curved surface of the ring frame **130***d*, so that the ring frame **130***d* is fitted with the upper surface **121** of each of the fan blades **120***d*. Moreover, in this embodiment, the outer surface (the second surface S**2**) of the ring frame **130***d* can be coplanar with the upper surface **121** of each of the fan blades **120***d* to reduce wind resistance. In this embodiment, the ring frame **130***d* is disposed on the upper surface **121** of each of the fan blades **120***d*. However, in other embodiments, the ring frame **130***d* may also be disposed on the lower surface of each of the fan blades **120***d*, or may also be disposed respectively on both the upper and lower surfaces of each of the fan blades **120***d*, and the disclosure is not limited thereto.

In summary, the ring frame of the fan module of the disclosure is connected to the outer endpoint of each of the fan blades, thereby strengthening the structural strength of the fan blades and reducing the situation that the fan blades are easily deformed or even broken due to the thinness of the fan blades. Moreover, the ring frame is designed in such a way that the camber of the inner surface facing the fan blades is larger, and the camber of the outer surface is gentler. This configuration can form a pressure difference between the inner surface facing the fan blades and the opposing outer surface of the ring frame, thereby promoting the airflow and improving the performance of the fan module. Therefore, the fan module can improve or at least maintain the performance of the fan module while strengthening the structural strength of the fan blades.

It will be apparent to those skilled in the art that various modifications and variations can be made to the disclosed embodiments without departing from the scope or spirit of the disclosure. In view of the foregoing, it is intended that the disclosure covers modifications and variations provided that they fall within the scope of the following claims and their equivalents.

What is claimed is:

1. A fan module, comprising:

a hub configured to rotate about a central axis;

a plurality of fan blades surrounding the hub, wherein each of the plurality of fan blades comprises a first end portion connected to the hub and a second end portion opposite to the first end portion; and

a ring frame connected to the second end portion of each of the plurality of fan blades, wherein the ring frame comprises a first surface facing the plurality of blades and a second surface opposite to the first surface, the first surface is a curved surface, and the second surface is a plane surface or an inclined surface and is coplanar with at least one of a lower surface and an upper surface of each of the plurality of fan blades,

wherein the ring frame further comprises an inner edge close to the first end portion and an outer edge close to the second end portion, and a thickness of the inner edge and a thickness of the outer edge are both smaller than a maximum thickness of the ring frame.

2. The fan module of claim **1**, wherein a camber of the first surface is larger than a camber of the second surface.

3. The fan module of claim **1**, wherein a distance from a peak point with the maximum thickness to the inner edge of the ring frame is 28% to 38% of a distance from the inner edge to the outer edge.

4. The fan module of claim **1**, wherein the maximum thickness of the ring frame is at least three times a minimum thickness of the ring frame.

5. The fan module of claim **1**, wherein a distance from the inner edge to the outer edge is at least five times the maximum thickness of the ring frame.

6. The fan module of claim **1**, wherein an outer endpoint of each of the plurality of fan blades is connected to one another to define a circle, and an inner radius of the ring frame is larger than 75% of a radius of the circle.

7. The fan module of claim **1**, wherein an outer endpoint of each of the plurality of fan blades is connected to one another to define a circle, and an outer radius of the ring frame is smaller than a radius of the circle.

8. The fan module of claim **1**, wherein the ring frame comprises a first ring frame and a second ring frame, the first ring frame is connected to the upper surface of each of the plurality of fan blades, and the second ring frame is connected to the lower surface of each of the plurality of fan blades.

9. The fan module of claim **1**, wherein a surface area of the first surface is larger than a surface area of the second surface.

10. A fan module, comprising:

a hub configured to rotate about a central axis;

a plurality of fan blades surrounding the hub, wherein each of the plurality of fan blades comprises a first end portion connected to the hub and a second end portion opposite to the first end portion; and

a ring frame connected to the second end portion of each of the plurality of fan blades, wherein the ring frame comprises a first surface facing the plurality of fan blades and a second surface opposite to the first surface, the first surface is a curved surface, and the second surface is a plane surface or an inclined surface and is coplanar with at least one of a lower surface and an upper surface of each of the plurality of fan blades,

wherein the ring frame further comprises an inner edge close to the first end portion and an outer edge close to the second end portion, and a thickness of the inner edge and a thickness of the outer edge are both smaller than a maximum thickness of the ring frame, and the maximum thickness of the ring frame is located between the outer edge and the inner edge.

11. A fan module, comprising:

a hub configured to rotate about a central axis;

a plurality of fan blades surrounding the hub, wherein each of the plurality of fan blades comprises a first end portion connected to the hub and a second end portion opposite to the first end portion; and

a ring frame connected to the second end portion of each of the plurality of fan blades, wherein the ring frame comprises a first surface facing the plurality of fan blades and a second surface opposite to the first surface, the first surface is a curved surface, and the second surface is a plane surface or an inclined surface and is coplanar with at least one of a lower surface and an upper surface of each of the plurality of fan blades,

wherein the ring frame further comprises an inner edge close to the first end portion and an outer edge close to the second end portion, and a thickness of the inner edge and a thickness of the outer edge are both smaller than a maximum thickness of the ring frame defined at a peak point of the curved surface.

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